length. From the fact that this error runs through the entire paper, it would almost seem as if the author was not aware of the distinction between wave-lengths and scale numbers. Using Ångström's scale he confuses wave-lengths with ten millionths of a millimeter; whereas in the case of D for example, the wave-length is nearly 6,000 times greater. If the author really means what he says, he asserts that the wave-length of the mean ray of the spectrum is one two-hundred and fifty-millionth of an inch instead of about one forty-thousandth, as we know it is.

Second, the author deems it of the greatest importance in the preparation of his solar photographs to use reflected rays exclusively; saying, p. 256, last line, "*at no time did the solar rays pass through glass;* all error that might arise during refraction was thus avoided." After this virtual condemnation of the use of refraction at all, he not only uses for comparison Ångström's wave-lengths made with achromatic lenses and a refracting grating, constructing even his chart upon them as a basis, p. 258, line 7, "the values assigned to the wave-lengths in this chart are those of Ångström"; but the very spectrum of oxygen by which the coincidence of the lines of this element with those of the sun spectrum were to be established, was photographed with glass prisms and achromatic lenses.

Third, the author states that the prisms with which the spectrum of oxygen was photographed were adjusted "to the minimum deviation of D'." Supposing D_1 to be meant, this precaution, which gives the appearance of extraordinary accuracy to the adjustment, is practically an impossibility with the apparatus employed. Minimum deviation of the D line as a whole could not under these circumstances be distinguished from that of either of its components, nor could that of D_1 be distinguished from that of D_2. Moreover, it is difficult to understand why he adjusts to minimum deviation for D' and not for G, near which the work is to be done. Instead of D', the line for which his apparatus was adjusted should have been chosen in the photographic portion of the spectrum, for example between G and H.

Fourth, on page 265, line 25, the author says that this "is a problem not to be solved by the comparison of two spectra of small dispersion." Hence it is a matter of some surprise to find that in getting his oxygen spectrum, he uses only "two flint glass prisms of 60," and for objectives, "achromatics of ten inches focus." The bright line spectrum of oxygen taken by Henry Draper, which the author in this paper inferentially attacks, was made, as we find on examination, with a direct vision battery of nine prisms and an observing telescope of forty-two inches focal length. The original negatives taken with the latter apparatus must consequently have been eight or nine times as long as the author's; and even these were none too large for the proper solution of the question.

Fifth, the author seems to have attempted to compare together a diffraction spectrum of the sun with a prismatic spectrum of oxygen. Such a comparison, by the method adopted, is manifestly of no value. Owing to the irrationality of dispersion of various refractive media it is an extremely difficult thing to compare accurately two prismatic spectra of different kinds. But the matter rises to an absurdity when a comparison is attempted between a grating spectrum and a prism spectrum. The graphic method, employed to supplement the direct method, does not appear to help the comparison, since the author nowhere gives both co-ordinates to the curve constructed.

Sixth, it is more than questionable whether the measurements of the solar lines actually made by the author are capable of the accuracy he assigns to them. The values in his table of wave-lengths are given to one hundredth of a division of Ångström's scale. As the author says on p. 257 that each division of this scale, which is one millimeter, was enlarged to five millimeters upon the paper scale on which the photographs were projected, to measure to one hundredth of a scale-division would require the measurements on the screen to be made to one-twentieth of a millimeter or the one five-hundredth of an inch, about; a degree of refinement highly improbable under these conditions. Moreover the accuracy of the results of such measurements is seriously impaired by the variation in the position of the lines on the screen, due to the fact that the large number of negatives (eight or nine apparently), required to give the whole photographic spectrum, must, unless special precaution was taken (of which there is no evidence), have been made with glass of different thicknesses. When projected in the lantern, this variation in thickness would necessitate a change in focus and so cause a change in the magnifying power. The smaller sizes of photographic glass vary in thickness from one to two millimeters. Consequently the displacement of the lines due to the difference of magnifying power arising from this cause would exceed considerably the limit of measurement, which, as above stated, was the one five-hundredth of an inch. But another and a more serious cause of inaccuracy must here be pointed out. From the data given by the author, it may readily be calculated that his original photographs of the oxygen spectrum, taken with two prisms of 60° and with lenses of ten inches focus, could not have been over half an inch long in the region from G to H. Since Ångström's chart from G to H is sixteen inches long, the author's spectrum would have to be magnified thirty-two times to make it the size of this. But as each millimeter of Ångström's scale was made five millimeters on the author's scale of measurement, the original negative as thrown on the screen must have been magnified one hundred and sixty diameters. Any one who has worked at all in spectrum photography, knows that it is utterly futile for purposes of measurement to magnify a photograph taken under these circumstances, as much as this, since then the size of the silver grains becomes larger than the details of the picture. In the absence of any precise statement the reader has to make the calculation for himself; but the figures above given cannot be far astray.

Seventh, there is only an appearance of accuracy when the attempt is made to fix the position of the oxygen spectrum lines to hundredths of one of Ångström's scale divisions. The projection method by which his solar lines were measured, has already been proved inadequate. And as to the method of graphical interpolation, used as auxiliary to the lantern, it does not appear that, as used by the author, it was capable of any such accuracy as that claimed. In constructing the curve, the iron lines are taken with Ångström's values for the wave-lengths; but these, though estimated to tenths, were read only to whole divisions of the scale. Moreover, only forty-seven iron lines were used in all, or one to every eleven scale divisions; the reading being to one one-hundredth of a scale division, or 1,100 numbers to one iron line. Since the author measured no wave-lengths directly, he was obliged to construct a considerable "portion of the curve from the wave-lengths of oxygen and air lines already given by various authorities." These values were taken, p. 258, from Watt's "Index of Spectra." On referring to this book, the values are given only to the units place. And even then, discrepancies amounting to from three to five entire units, or from three hundred to five hundred times the author's limit, appear in the wave-length as given by the various authors relied on for the measurements employed in the paper before us.

Eighth, the author nowhere states the peculiar character of the lines in the oxygen spectrum and appears not to know that they have any. He has apparently taken it for granted that the lines of oxygen are intrinsically as sharp as the lines of the solar spectrum. But this, at least in many instances, is known not to be the case. Consequently it is quite impossible to measure the oxygen lines as accurately as the solar lines, and even these, as has been shown, cannot be measured to the accuracy which the author claims. Ångström himself admits that there may be an error of one-tenth of a division in his scale numbers.

It would seem sufficiently obvious from what has been said that the results given in this paper are entirely vitiated by the errors of method and of experiment which it contains. The author must not be confounded, because of the similarity of initials, with the distinguished investigator, Dr. J. W. Draper.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

UNIVERSITY education for women may be taken as firmly established in England. The names of nine out of eleven female candidates have just been posted at Burlington Gardens as having passed the winter matriculation examination of the University of London, half-a-dozen in the honours division, besides three more in that next below, and are thus now on the high road to its B.A. degree, on the occasion of its first decorating their sex three academical years hence. From two interesting articles in the *Daily News* it is seen that Girton and Newnham Colleges have attained to unexpected success. The former is so much too small for the number of students that yearly flock to it that it is to be nearly doubled in size. At both institutions the students work much more earnestly than the average student of the hitherto privileged sex, and the examinations passed, at least at Girton, would

suffice to give the most successful student a high place in the Cambridge list of Wranglers. No doubt, in the near future, English girls all over the land will have as few obstacles in the way of their higher education as English boys.

MR. H. T. WOOD, of the Society of Arts, writing to Col. Donnelly, of the Science and Art Department, South Kensington, informs him that sufficient funds will be provided by the City Companies for the payment of teachers of classes for instruction in technology, on the same scale as that on which teachers of science classes are now paid by the Science and Art Department, and without any proportionate reduction, as stated in the Society's Programme of Examinations (p. 14), on the ground that all the amount at the disposal of the Society might be insufficient to allow of the full payment in all cases. Mr. Wood asks that this important fact be brought under the notice of the Secretaries of Science Classes and Schools. The arrangement will apply to the examinations held in May next.

DR. T. LAUDER BRUNTON, who was recently appointed to the Thomson Lectureship in the Aberdeen Free Church College, delivered the opening lecture on Monday, the 3rd inst. The course will consist of ten lectures.

THE University Library at Strassburg, founded after the recent Franco-German War, numbered no less than 470,000 volumes at the end of 1878.

WE are glad to see that in the second number of the *University College of Wales Magazine* science finds a corner in the shape of "Museum Notes." One of these, by Prof. Rudler, is a brief *résumé* of what is known of the Moa, *apropos* of a collection of moa-bones in the College Museum.

SCIENTIFIC SERIALS

Journal of the Franklin Institute, January.—The error of some wild statements made about the size and cost of the cable that would be needed to convey the power of Niagara Falls several hundred miles by electricity is here shown by Professors Thomson and Huston, who calculate, *e.g.*, that 1,500 to 3,000 horse-power could be conveyed 1,000 miles (50 per cent. out of 3,000 horse-power) with a copper cable about ¼ inch in thickness. Less than ½ inch would suffice for 500 m. For consumption of 1,000,000 horse-power a 3-inch cable would suffice. The same authors describe a curious thermo-magnetic motor, and an induction apparatus for reversed currents.—Dr. Henry Morton finds the coating of the "luminous clocks" sulphide of calcium attached with some resinous medium, and seems hopeful that advances in this direction may by and by give us houses lit at night by phosphorescent walls.—Mr. Huston gets some remarkable effects (needing confirmation from repeated tests) in subjecting iron to a continued and constantly increasing strain.—Dr. Dudley considers toughness, rather than hardness, the essential quality for durability of steel rails.—An automatic machine for playing the game of tit-tat-to is described by Mr. Freeland.

Reale Istituto Lombardo di Scienze e Lettere, vol. xi. fasc. xix., xx.—On some derivatives of ethyl-paraoxybenzoic aldehyde, by S. Corbetta.—The English sanitary laws, by Dr. Zucchi.—On the use of salts of berberine as febrifuge, and on tumours of the spleen from malarian infection, by Dr. Zucchi.—Studies on milk at the Pavian laboratory of cryptogamic botany, by Drs. Pirotta and Riboni.—Value of two meteorological instruments of Bellani, by Prof. Cantoni.—Observations on the seismic microphone of De Rossi, by Prof. Cantoni.

Vol. xii. fasc. i.—Studies on milk (continued), by Drs. Pirotta and Riboni.—New physio-pathological researches on pulmonary phthisis, by Prof. de Giovanni.—First lines of introduction to the study of the Italian bacteria, by S. Trevisan.—On modular equations, by S. Klein.—On pentahedral equations of surfaces of the third order, by Prof. Beltrami.

Bulletin de l'Académie Royale de Belgique, No. 11, 1878.—Besides M. Montigny's paper on variations in the scintillation of stars (referred to last week), this number contains a valuable memoir by M. Fredericq on the organisation and physiology of the poulpe (or octopus), which he studied at the laboratory of Roscoff. The arterial blood yields a blue colouring matter (called *hæmocyanine*), which corresponds somewhat to hæmoglobin, but contains copper, not iron. Both respiration and nutrition of tissues depend on it. The heart has both accelerating and moderating nerves. The blood pressure is considerably greater than in cold-blooded vertebrates; the venous system shows rhythmic contraction; exterior water does not mix with the blood; the urine contains neither urea nor uric acid, but a substance like guanine, &c. M. Fredericq localises the centres of the respiratory movements, and gives some interesting observations on the "chromatic function."—M. Van der Mensbrugghe finds confirmation of his theory of the variations of potential energy of liquid surfaces, in some peculiarities of liquid sheets, which he accounts for on thermodynamical principles.—M. Lienard communicates researches on the structure of the digestive apparatus of Mygales and Nephiles, and M. Longchamps concludes his synopsis of the Gomphines.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, January 30.—"On the Effects of Heat on the Di-iodide of Mercury, HgI_2," by G. F. Rodwell, Science Master, and H. M. Elder, a pupil, in Marlborough College.

The authors, in continuation of experiments of a similar character previously communicated by one of them to the Society, on the anomalous expansion of the iodide of silver, have examined the iodide of mercury with a view to the detection of similar anomalies. This body is dimorphous, existing in the form of yellow prismatic crystals, which change under external mechanical influence, or during the process of cooling, to brilliant scarlet octohedrons with a truncated summit. The mass melts at 200° C. to a red-brown liquid, which volatilizes at a slightly higher temperature. The following volumes were determined at the temperatures given:—

	Volume.		Specific Gravity
Liquid at 200° C.	1·1191147	...	5·286
Solid ,, ,, ...	1·0190453	...	6·179
Yellow prismatic condition at 126° C.	1·0115378	...	6·225
Red octohedral condition at 126° C.	1·0043337	...	6·276
,, ,, ,, at 0° C.	1·0000000	...	6·297

Thus the di-iodide of mercury possesses one coefficient of expansion = ·0000344706 for 1° C. between 0° and 126° C., it then undergoes a sudden expansion = ·00720407 in changing from the red octohedral to the yellow prismatic variety, while between 126° C. and the melting-point (200° C.), it expands under a higher coefficient than before = ·0001002953 for 1° C.

"A Comparison of the Variations of the Diurnal Range of Magnetic Declination as recorded at the Observatories of Kew and Trevandrum." By Balfour Stewart, F.R.S., Professor of Natural Philosophy in Owens College, Manchester, and Morisabro Hiraoka.

1. Generally speaking, maximum points or risings in the one curve must be associated with maximum points or risings in the other, rather than with minimum points or depressions. Indeed, the researches of Broun and others, from a different point of view, strengthen this conclusion, which is, however, abundantly supported by a glance at the curves themselves.

2. The oscillations of the Trevandrum curve are greater than than those of the Kew curve.

3. In many cases where there is a want of striking likeness between the oscillations of the two curves, there are yet noticeable traces in the one curve corresponding to the oscillations of the other. There are, however, a few cases where there is a want of apparent likeness.

4. In general, though not invariably, the oscillations of the Trevandrum curve follow rather than precede the corresponding oscillations of the Kew curve.

February 6.—"Absorption of Gases by Charcoal. Part II. On a new Series of Equivalents or Molecules." By R. Angus Smith, Ph. D., F.R.S.

In the *Transactions* of the British Association, 1868, Norwich, on p. 64 of the "Abstracts," there is a preliminary notice of an investigation into the amount of certain gases absorbed by charcoal. I made the inquiry from a belief previously expressed in a paper of which an abstract is in the *Proceedings* of the Royal Society, p. 425, for 1863. I said in that paper that the action of the gas and charcoal was on the border line between physics and chemistry, and that chemical phenomena were an extension of the physical; also that the gases were absorbed by charcoal in whole volumes, the exceptions in the numbers being supposed to be mistakes. The results given were:—